date on the evidence of the plant-remains found in the coal seams which are associated with it.

Owing to the difficulty of determining questions of relative superposition in a country so densely clothed with vegetation, and to the insignificant depth of the sections, natural and artificial, which are accessible, coupled with the remarkably disturbed condition of large tracts of the sedimentary rocks—it is not possible to define at present the relations of the igneous to the sedimentary rocks of the district. Nevertheless, such evidence as I have myself been able to collect goes to support the hypothesis that the last outbreak of volcanic activity was posterior in date to all but the more modern deposits of shales, clays, river-gravels, &c., or, in other words, that it preceded more or less immediately, the last submergence of north-west Borneo—though separated from that submergence by a long interval, and possibly being the concomitant of an antecedent elevation of the land.

The traces of this outbreak remain in the existence of thermal springs, two at least of which occur in association with hills of trappean and basaltic rocks; the country in many parts is dotted with hills of basalt, columnar basalt, and felspathic porphyries, and in the intervening lowlands is seamed with dykes of porphyritic, hornblendic, and siliceous rocks; the sedimentary strata are greatly disturbed when the igneous rocks occur, being often upheaved at high angles and much plicated, and locally the sandstones and shales have been metamorphosed; whilst masses of a volcanic-conglomerate (?) are occasionally met with.

Philippine Islands, September 27 A. H. EVERETT

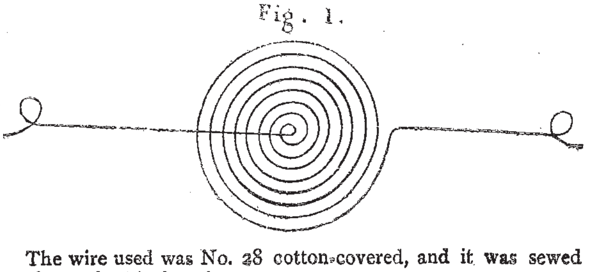
New Form of Telephone

HAVING had the pleasure of listening to Mr. Preece and Prof. Graham Bell explaining that most wonderful invention, the telephone, at the late meeting of the British Association in Plymouth, I endeavoured to obtain the instrument for my own use, and was ultimately successful.

It soon struck me that if the disc or diaphragm whose vibration causes the induced current in the coil of copper wire must be a magnetic substance, and not simply a conductor, then if I could succeed in getting an electro-magnet to vibrate in a similar manner it might be possible to get as powerful a sound.

With this object in view a coil of insulated copper wire was fastened to a card, as shown in Fig. 1.

Fig. 1.



The wire used was No. 28 cotton-covered, and it was sewed to the card with thread.

The iron disc was taken out of one of the telephones, and the coil-diaphragm put in its place through which a current was passed from a single Bunsen cell. On making connection with the other telephone, talking, singing, and whistling were heard distinctly at both.

Various coils have since been tried both with thicker and also thinner wire, but as yet the results have not been as good as when the iron disc is used.

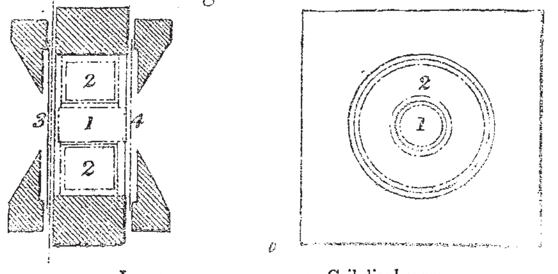
When two such coils are used, one superposed on the other, the loudness of the sound transmitted is increased to some extent. The same result is produced by adding another Bunsen cell. With a Daniell's cell the sound is very feeble. When a coil is placed in each telephone the result is rather unsatisfactory as yet.

It has also been noticed that a simple conductor as a coil of copper wire also transmits sound but very faintly.

A small apparatus (Fig. 2) has been made to show the effects above described. A piece of wood about three inches square and about one inch thick has a hole bored through it about two inches in diameter. A reel (2) containing about 250 yards of silk-covered copper wire is placed in the hole with a piece of soft iron about half an inch in diameter as axis (1).

A coil-diaphragm (3) is placed across one end of the hole at a very short distance from the soft iron core, and is covered by a mouth-piece. Across the other end of the hole at a similar distance from the core is placed a thin iron disc (4) which is also covered by a mouth-piece. On a current being passed through the coil-diaphragm this apparatus acts as a telephone, and messages can be sent from either side of it.

Fig. 2.



1. Iron core.
2. Coil of wire.
3. Coil diaphragm.
4. Iron disc.

The iron disc and core may be removed, and the coil-diaphragm alone acts in an exactly similar manner.

The above are the results of some experiments which have occupied my spare time lately, and not having seen anything similar published I forward them to you as they are rather interesting. The whole of the experiments have been conducted with the aid of my friend, Mr. G. B. Nicoll, who has also made many important suggestions. JAMES M. ROMANIS

Shooting Stars

THE number of shooting stars seen here during the last six months (July to December) is 2,259 in 168 hours of watching. This number includes 385 Perseids observed between August 3 and 16. Of the remaining 1,874 1,028 were seen during seventy-five hours in the mornings and 846 during ninety-three hours in the evenings. After making certain allowances for time spent in registering the paths (and omitting the Perseids), the horary numbers appear to have been as follows:—

16·4 A.M., 10·9 P.M., 13·4 A.M. and P.M.

From these figures I estimate that the aggregate number of shooting-stars as bright as, or brighter than, 5th mags., which entered the earth's atmosphere in this particular part of the world by night and day during the last six months, was about 236,700. The horary number has already been mentioned as 13·4 for one observer. Now a single pair of eyes certainly cannot command more than a fourth part of the visible sky, so that we must adopt 53·6 as the horary rate over the whole sky. From this we readily deduce the diurnal number as 1286·4, and the aggregate for the six months, 236,697·6 as above.

When it is further considered that the average height of ordinary shooting-stars is only about seventy miles, and that therefore observers at widely distant stations must each see a distinct set altogether, we are able to form some remote idea of the vast number that enter our atmosphere every day.

Bristol, December 26, 1877 W. F. DENNING

Gentiana asclepiadea and Bees

THIS gentian is very abundant on the mountain slopes round Engelberg, as visitors to that part of Switzerland well know. As I was botanising in the neighbourhood, in the autumn of this year, I observed that most of the flowers were pierced with a round hole at the base. Presently I saw a bee come to one of the pierced flowers, and thrust in its proboscis in search of honey. The flowers of this beautiful, sweet-smelling gentian are long and funnel-shaped, and very contracted at the base, and, as the bee that visited it was a "fair large" one, like Sir Torre's diamond, and not of the narrow hive-bee type, it could not possibly have effected its purpose by entering the flower in the usual way at the top, and had no doubt resorted to this method of extracting the honey. I only saw this one kind of bee visit the flowers, but I saw many of them at work, and all acted in the same way. One of them came to some of the flowers, which I had gathered, as I held them in my hand. I cannot say that I saw a single flower actually pierced by a bee; the day was warm, even for Engelberg, and the bees were very

quick in their movements, which increased the difficulty of observation, but that the bees themselves were the agents, in making the holes, there can be no reason to doubt.

Highfield, Gainsborough, December 21 F. M. BURTON

Photography Foreshadowed

THE first prophetic allusion to the photographic art, the discovery of which was to take place eighteen centuries later, is perhaps found in the story of the miraculous occurrence told in the life of St. Veronica.

The second instance is about the year 1690; but intermediate instances may probably be found. I extract from the works of Fénelon[1] the following passage from an imaginary voyage in 1690:—"There was no painter in the country, but when anyone wished to have the portrait of a friend, a beautiful landscape, or a *tableau* which represented any other object, he put water in large basins of gold or silver; then placed this water opposite the object he wished to paint. Soon the water congealing became like a looking-glass, in which the image of that object remained ineffaceable; and it was a picture as faithful as the brightest mirrors." One could wish that the author had entered into detail as to the manner "of placing this water opposite the objects he wished to paint."

The third instance is about 1760, that is seventy years later, and seventy-nine years before 1839, the date of Daguerre's discovery. It is reported[2] by Ed. Fournier, who extracted from what he calls "un assez mauvais livre," written by a certain Tiphaigne de la Roche[3], the entire passage, extremely curious, but rather long. This passage contains many details. The "water" of Fénelon is replaced by "a material very subtle, very viscous, and very ready to dry and harden." "They" (certain "elementary spirits") coat with this material a piece of linen, and present it to the objects which they wish to paint," &c.

In the two last examples the pictures formed reproduce the images of the objects, with their natural colours and their forms, so that the objects are seen as if reflected in a mirror. The photographs of the present day are still very far from this ideal perfection, which, however, they will probably never cease to approach without ever being able to reach.

Rotterdam J. A. GROSHANS

Average Annual Temperature at Earth's Surface

HAVING lived for many years both in the southern and northern hemispheres, I have a very strong impression that if means were taken to ascertain, with more or less approximation, the average annual temperature at the earth's surface, by a combination of the daily averages of a sufficient number of places of observation, there would be found a very considerable difference in the yearly values of the said average annual temperatures. But whether, on inquiry, there should prove to be a decided difference or an absolute agreement between these averages, the fact in either case would surely be worth ascertaining, and could not fail to be instructive. It might be objected that it would be impossible to obtain the observations of the daily average temperature from such a number of observatories as would render the desired annual average for the whole earth of any value, but I think this objection overstates the difficulty. Suppose that the subject were taken up by some one of the meteorological authorities in Great Britain, it would not be difficult to obtain from existing daily records, a good average annual value for the temperature of the British Islands. Similarly, an average annual value could be obtained for the temperature, from the daily averages in the various colonies and dependencies of the British empire; and I take it to be certain, that the conductors of the various meteorological observatories all over the empire would cheerfully respond to an invitation to co-operate in such a work. In a similar scientific spirit it is to be hoped that the observatories of all civilised countries would be willing to exchange their observations, and an approximate result could thus be arrived at, possibly in two or three years. Certainly, it might be at first a rough approximation only, but it would be yearly becoming better with the rapid increase of meteorological observatories all over the world. And as it is not too much to hope that, sooner or later, the whole habitable earth will be civilised and covered with observatories, it is certain that the figures ultimately obtained to represent the average annual temperatures at the earth's surface would have the value of scientific approximations of considerable accuracy. If this be so, it cannot be too early to begin these statistics now.

Supposing that these annual averages should exhibit a difference in their yearly values, it is probable that these differences would vary in sympathy with the total sun-spot areas of the years to which they belonged. What could be done for temperature, could be done at the same time for other subjects of meteorological investigation, and it is impossible to anticipate at present what light these tabulated annual averages might be able to throw upon various problems of solar and terrestrial physics.

Balham, December 4 D. TRAILL

[1] Paris, Auguste Desrez, 1837, tome 2^me, p. 643.
[2] Le Vieux-Neuf, Histoire Ancienne des Inventions et Découvertes Modernes Paris, Dentu, 1859.
[3] Giphantie, à Babylone, MDCCLX., 12°.

ON A MEANS FOR CONVERTING THE HEAT-MOTION POSSESSED BY MATTER AT NORMAL TEMPERATURE INTO WORK

IN a previous article[1] we considered, how, by a simple mechanical means, diffusion renders it possible to derive work from matter at normal temperature. As the subject is an important one we propose to develop it somewhat further here.

2. The normal temperature of objects on the earth's surface represents a vast store of energy in the form of molecular motion. The sea (for example) at normal temperature possesses an amount of molecular energy which (by computation), if it were entirely utilised, would be competent to lift it to a height of upwards of seventy miles. The air and the crust of the earth itself possess comparable amounts of energy. It might therefore well be asked beforehand whether it is not possible to transfer some of this intense molecular motion to masses and utilise it. It may be observed that this intense store of energy is being continually dissipated in space in the form of waves (by radiation). The energy possessed by the molecules of matter, however, maintains (as is known) a constant normal value on account of the waves of heat received from the sun, whose mechanical value at the earth's surface (as represented by the results of Herschel and Pouillet) is normally equal to about one-horse power per square yard of surface. Here, therefore, we have a continual store of motion kept up in the molecules of matter on the earth's surface to be wasted in great part in imparting motion to the ether of space. It would certainly look, *à priori*, as if there ought to be some means of utilising this store of motion.

3. The second law of thermodynamics would (as is known) assume that this would not be practicable. This law was propounded simply as what was considered a legitimate inference from the observed behaviour of heat. But a great advance in the knowledge of the nature of heat has been made since that time, and it should be noticed that the law is (admittedly) by no means *theoretically* necessary or requisite to satisfy the principle of the conservation of energy. Indeed a conceivable case opposed to it has been pointed out by Prof. Maxwell, though one not capable of being practically carried out. It was my purpose in the last article to direct attention to a physical process opposed to the law and admitting of practical realisation, in the effects attendant on the diffusion of matter. At the time when this law was enunciated the character of the motion termed "heat" (as illustrated in the now accepted kinetic theory of gases) was unrecognised, and therefore the *mechanism* of the diffusion of gases was not understood. Under these conditions, therefore, it would not be much a point for surprise if increase of knowledge should show the law not to be generally applicable (or not to admit of that general application which is implied by the use of the term "*law*").

4. It may serve greatly to facilitate the following of this subject if we visualise the relations of heat and work more closely. Since "*heat*" is simply a *motion* of small portions of matter (termed "molecules"), and since the

[1] "On the Diffusion of Matter in Relation to the Second Law of Thermodynamics," see NATURE, vol. xvii. p. 31.